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ABSTRACT

Because it is a well-accepted fact that young persons have more than their share of automobile crashes and because the task of driving is a complex one that requires practice to be mastered, it is proposed that a careful human factors analysis of the task of driving be undertaken based on empirically demonstrated differences among driver groups. Such an analysis should include the following procedures: identification of human performance parameters relevant to driving, empirical determination of differences between novice and experienced drivers, determination of the amenability to training of the identified factors, development of training procedures using interactive devices and simulators when possible, compilation of procedures into a driver preparation program, coordination with televised material covering the classroom portion of driver education, development of a parent involvement program, determination of a minimum level of each factor required for different driver groups, compilation of scales into performance test batteries and elimination of overlap, tailoring of the test battery to existing constraints, use of the test battery in a licensure demonstration project, investigation of the possible role of factors in crashes of different driver groups, determination of the compatibility of driver performance with highway engineering standards and vehicle standards, modification of standards and practices where appropriate, and imposition of restrictions on driver populations where necessary. The human factors approach appears to be one way of developing an intelligent comprehensive driver-vehicle-highway system. (MN)

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Patricia F. Waller

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Young Drivers: Reckless or Unprepared?

It is increasingly recognized that motor vehicle injuries constitute a major public health and economic problem in the nation today. Hartunian, Smart, and Thompson (1980) examined the number of new cases each year in the U.S. of cancer, motor vehicle injuries, coronary heart disease, and stroke, as well as the costs associated with these new cases. They found that for cancer, coronary heart disease, and stroke the number of new cases totalled a little over one and a half million. For motor vehicle injuries the number was over four million. When the costs associated with just the new cases were considered, motor vehicle injuries ranked second only to cancer.

A major reason for the high costs of motor vehicle injuries is that they strike the young disproportionately, and especially persons in their teens and early twenties. A recent report from the U.S. Surgeon General showed that over the last 20 years every age group in the United States experienced an increase in life expectancy with the exception of the group age 15 through 24. These young people showed a higher death rate than 20 years earlier, and the major cause was motor vehicle injuries (US Department of Health Education and Welfare, 1979). Deaths in this age range represent a major economic, as well as human, loss. Serious injuries can be even more costly. Motor vehicle injuries are by far the leading cause of new cases of paraplegia and quadriplegia, accounting for approximately half. When the victims are young people, there is a long term commitment of costly health care resources. Furthermore, motor vehicle crashes are the leading cause of death and serious injury in the peacetime military. Even in the navy motor vehicle crashes account for the majority of deaths!

The relationship between youth and motor vehicle crashes has been well established, and it is not confined to any one nation. A recent report from Canada (Mayhew, Warren, Simpson, and Haas, 1981) documents the magnitude, universality, and consistency of the problem. Historically perhaps the major program that has developed in response to the problem is driver education. Early evaluations of driver education showed promising results, and the insurance industry responded by allowing reductions in premium to persons completing approved courses of instruction. However, in 1969 McGuire and Kersh published a landmark report in this area and concluded that "...high school driver education, as now constituted, offers little or no promise of ...modification [of accident-producing behavior]."

More recently, some researchers have asserted that high school driver education does indeed have an impact on accident-producing behavior in young people, and that the impact is a negative one, that is, high school driver education is <u>contributing</u> to motor vehicle injuries and deaths (Robertson and Zador, 1978). Because most states will not license young people below the age of 18 unless they have completed driver education, the existence of the program enables licensure of young people who otherwise would not be driving. It has therefore been recommended by some that driver education in the public schools be eliminated entirely, thus reducing the number of 16 and 17 year old drivers (Insurance Institute for Highway Safety, 1981; Robertson, 1981).

The National Highway Traffic Safety Administration funded the development of the Safe Performance Curriculum (SPC), a comprehensive driver education program that builds on previous NHTSA research. The SPC includes approximately 32 hours of classroom instruction, 16 hours of simulation instruction, 16 hours of driving range instruction, three hours of instruction in evasive maneuvers, and five hours of on-street

instruction, two of which are behind the wheel. NHTSA has sponsored a major demonstration project in DeKalb County, Georgia, in which the SPC is compared with the Pre-Driver Licensing Curriculum (PDL), a course of study that is more characteristic of many high school driver education courses. The PDL includes about 20 hours of classroom, range, and simulation instruction. A second comparison group is made up of students who receive no high school driver education, although they can still obtain training from commercial schools or from their parents.

Early results of the study showed little in the way of significant differences (Weaver, Stock, Ray, and Brink, 1981), although later results appear somewhat more promising (Stock, Weaver, Ray, Brink, and Sadof, 1983). However, even if the SPC is shown to be superior, it must be noted that it represents a much more expensive program. With society's growing reluctance to fund such programs, it may not be realistic to expect much in the way of practical application of any positive findings. What is perhaps more unfortunate is that any negative findings are likely to be used as a basis for dismissing driver education out of hand and refusing to continue funding in this important area.

It is not the purpose of this paper to discuss the pros and cons of the studies, past and current, that attempt to evaluate driver education. Rather it is to emphasize that regardless of what is done about driver education programs, young people <u>are</u> going to learn to drive. And when they do, they will make more errors at the beginning than they will later. Such performance is entirely to be expected. No one expects to sit down to a piano for the first time and play a Beethovan sonata, nor does one expect to present a serious challenge to John McEnroe if it is one's first foray onto a tennis court. In these areas we recognize and accept the need for years of quality instruction and devoted practice, not to mention at least a modicum of talent. It is totally unrealistic to expect more rapid progress in a skill as complex as driving. Of course, we have to

acknowledge that most people in our society will become drivers, regardless of whatever their potential ability may be. Even so, we should be able to achieve much greater sucess in our driver preparation programs.

I should like to propose an entirely different approach to the problem of preparing the young driver, an approach that is widely recognized in other areas but one that has not been seriously considered here. I would suggest that the major reason driver education has failed to show any greater benefits is that we have never conducted the research that needs to be done to give the driver education instructor the tools he or she needs. In industry, human factors specialists have analyzed a multiplicity of tasks to simplify skill acquisition and reduce accidents. In the military it became evident during World War II that task analysis would greatly reduce casualties in pilot training. Before we launched astronauts into space, a great deal of time, effort, and money went into carefully analyzing the most effective ways of conducting the necessary routines and training the space voyagers. In athletic competition we used high speed film and computer analyses to identify opportunities for improved performance. Yet we continue to ignore the potential for payoff if similar techniques were applied to the one complex task that is shared by the majority of the adult population in most industrialized nations today. The driving task has never been subjected to a truly empirical analysis that identifies what differentiates skilled from unskilled performance.

It is well recognized that experienced drivers perform more effectively, and safely, than novice drivers. Yet we do not really know what makes the difference. One expert, B. J. Campbell, has said that experience may be considered to be an inefficient time comsuming programming of a series of critical events that provide feedback to the driver and thus teach him more about the driving task (that is, if he is

fortunate enough to survive in the interim). The question for driver preparation is whether the careful programming of clearly identified key events could improve upon experience as a teacher.

To approach this question requires, first, the identification of those human performance parameters that may be relevant to driving. Once identified, these parameters must be examined in both novice and experienced drivers. To document the differences between the novice and the experienced driver will require considerable time and effort, but there should be no attempt to cut corners at this stage, since the findings will have major relevance for much more than driver preparation.

Once the relevant parameters have been identified and verified with novice and experienced driver groups, the additional steps to develop a comprehensive driver preparation program fall into logical sequence. The next step is to determine which of the relevant behavioral skills are amenable to training. Procedures for modifying these skills should then be developed and compiled into a comprehensive driver training program including classroom education and behind-the-wheel experience. Finally, the entire program should be coordinated with a graduated driver licensing program.

The following sections describe each of these steps in more detail.

Proposed Program for Driver Education and Training of Young Drivers

1. Identification of Human Performance Parameters Relevant to Driving

The first step in any meaningful research program on performance measurement is a careful analysis of the task under consideration. In the field of driving our programs have largely been based on the best judgment of "experts" in the field. It is understandable that this has been the

case when one reflects on what is required in a more empirical approach. Nevertheless, until there is a careful empirical analysis of the driving task, our programs will continue to be based on nothing more than the collective judgment of "experts" in the field, which is often no more than pooled ignorance. There is methodology available that will enable the development of more effective procedures than are currently in use.

To identify those performance-related characteristics that are relevant to driving, two tasks must be accomplished. First, it is necessary to identify candidate parameters for further investigation, and, second, to assess the candidate parameters in terms of feasibility criteria.

Identification of behavior parameters. The identification of potentially relevant behavior parameters should begin with a review of literature concerning parameters of human performance that can be related to human output. The parameters identified from the literature should be submitted to a select panel of experts, not only in the area of driving but also in the more general area of human factors skill training. After reviewing and further evaluating the identified parameters, the panel should identify which parameters (including any additional ones contributed by the panel) should be retained for further consideration.

Feasibility criteria. Simply because an identified parameter may differentiate between novice and experienced drivers does not not automatically qualify it for a place in a driver preparation program. For example, should it be established that biorhythms influence human output and possibly affect driver performance, this parameter may still be discarded because of the difficulty of measurement and of making practical use of the information. On the other hand, difficulties in measurement per se would not necessarily eliminate a parameter. For example, the

technology for measuring eye movement patterns of drivers leaves much to be desired. Yet if it is clearly established that there are novice-experienced driver differences in eye movement patterns, and if the dimensions of these differences are defined, the information could be systematically used in driver preparation. Once it were established that certain training procedures enable the novice driver to use his eyes in a manner more similar to that of the experienced driver, it would no longer be necessary to measure the eye movement patterns of every driver undergoing training.

2. Empirical Determination of Novice-Experienced Driver Differences

Once promising human performance parameters have been identified, they must be examined to determine how they vary as a function of actual driving performance. So far as novice-experienced drivers are concerns, this task will, in effect, develop the learning curve for the acquisition of driving skill. Driver groups to be examined empirically might include permit level drivers (just beginning behind-the-wheel experience, not yet ready to drive without supervision), novice drivers (holding a license to drive alone but still inexperienced), drivers with two years experience; drivers with five years experience; drivers with ten years experience; and drivers with 20 years experience. In selecting drivers for testing, driver histories should be used to help define the criterion groups. Thus, the more experienced drivers should be characterized by relatively good driving records. Drivers with less experience could be subdivided into two groups, one with clean records and the other with violations and crashes. Only skills that can be shown to differentiate between novice and more experienced drivers with relatively good records would be considered for incorporation into a driver preparation program.

It may also be useful to test the candidate parameters on other driver

groups, such as professional drivers with high mileage and clean records, problem drivers with multiple crashes, and elderly drivers whose performance may be adequate for reasons other than sheer psychomotor skill.

A candidate list of parameters that might be considered for further investigation could include perception, decision making, performance under stress,, and variability of performance.

Perception. Rockwell and his associates at Ohio State University have shown that novice drivers exhibit eye movement patterns that differ from those of experienced drivers (Bhise and Rockwell, 1971; Mourant and Rockwell, 1971; Rockwell, 1971; and Zell, 1969). Using elaborate equipment to photograph eye movements of drivers on the road, they found that novice drivers first tend to fixate on objects to the right hand side of the road but in time focus straight ahead with little scanning from side to side. In contrast, more experienced drivers were found to watch the road ahead but engage in more scanning behavior and show briefer durations of fixation.

Several tests of hazard perception have been developed (Jones, 1977; McPherson and Kenel, 1968; Shuster, 1971; Soliday and Allen, 1971; and Spicer, 1964), with some positive resuts. Differences have been found between younger and older drivers (Soliday and Allen, 1971), as well as between accident-free and accident-involved subjects (Spicer, 1964).

Closely related to the concept of hazard perception is risk perception and risk acceptance. Even if no differences were found among driver groups in perception of risk, there may be differences in the response to the hazard and in the extent to which one is willing to engage in risk taking behavior in relation to the hazard. A person may be a risk taker because he fails to perceive the risk or because he sees the risk but accepts it.

Decision Making. In most driving situations the driver is faced with

two major types of decisions. The first concerns the actions to be executed while the second usually relates to the timing of those chosen actions. Such decisions are especially critical in situations related to passing, following, or merging. Poor decision has been reported to be a contributor in accident causation. Furthermore, there is some evidence that drivers are generally poor decision makers where passing is concerned, tending to overestimate short distances and underestimate long distances (Franklin Research Institute, 1970). However, Lucas (1973) showed that training, coupled with feedback, could improve drivers' judgments in a passing situation. Thus it appears that this area may be a fruitful one for further research.

Performance Under Stress. Stress may be defined by different types of parameters such as fatigue, vigilance, complexity, uncertainty, alcohol, and drugs. Generally, a degradation in performance accompanies the inducement of stress situations. A good example is performance under fatigue conditions. Fatigue may be induced either by sleep deprivation or by performance of a monotonous task over an extended period of time (e.g., Brown, 1967; Forbes, Katz, Cullen, and Deterline, 1957; Herbert and Jaynes, 1964; Hulbert, 1963 and 1972; McFarland and Mosely, 1954; Platt, 1964; Safford and Rockwell, 1967). Practially all studies have found some form of performance decrement under fatigue conditions.

Because fatigue degrades performance, it could be used to assess driver performance (Herbert, 1963). Under fatigue conditions, those skills that are most overlearned should hold up better than ones that are not so well learned. Although novice drivers (usually young) may be less easily fatigued, it may be worthwhile to conduct limited laboratory studies to examine the extent to whch different driver groups vary in their performance under certain driver related tasks as a function of fatigue.

In addition, while novice drivers may score higher than more experienced drivers on vision tests, the more demanding task of maintaining vigilance over an extended period of time may show differences in the opposite direction. In any event, driver performance under fatigue and vigilance-demanding conditions deserves more attention.

Stress can also be induced by adding auxiliary tasks to the primary task. Performance has been found to deteriorate in subjects who are required to perform two tasks simultaneously (Stephens and Michaels, 1964). Roscoe (1977) has reported that in the selection of pilots there is evidence that the ability to shift priorities or divide attention among several competing tasks shows a relationship to pilot performance. He further indicates that it appears that this skill can be trained in a part task situation and that the training transfers to the total piloting task. One of the difficulties experienced by the novice driver is that he is so preoccupied with the mechanics of handling the vehicle that he may have difficulty paying adequate attention to the driving environment, that is, he has difficulty dividing his attention. Skill acquisition in performing multiple tasks or dividing attention may prove to be important in driver preparation.

Driving may also be more stressful when the environment provides reduced information to the driver (as in night driving) or when the driver is in less than optimal condition (as in drivers under the influence of alcohol or medication). Therefore examination of how different driver groups perform under such conditions may be useful in developing a comprehensive driver preparation program.

Variability of Performance. There is evidence that novice drivers show greater variability in their performance than do more experienced drivers. Such variability is exhibited even in measures of time required

to drive a closed course (Bathurst, 1978). Repeated test runs on the same drivers lead to greater uniformity in time for experienced drivers than is found for less experienced drivers, although even experienced drivers may vary greatly from one another in average time. This parameter is qualitatively different from the others discussed in that it may permeate all of the other parameters, e.g., eye movement patterns, maintenance of vigilance, risk perception. In that sense it may prove to be an aspect of performance rather than a special skill factor that stands alone. Nevertheless the suggestion that this may be a characteristic of novice drivers indicates that it is worth pursuing as a measure of level of performance. It might be noted that greater variability of performance has also been reported in older drivers who are showing a decrement in overall functioning.

It may be found that some skills that differentiate between novice and experienced drivers are found to exist at an even higher level in the professional driver. For example, the maintenance of an adequate "space cushion" around the vehicle, that is, the available space in which to maneuver safely, may be found to differ for novice and experienced drivers. In a passenger car the space cushion may extend for several feet to each side of the vehicle as well as several yards in front. For the operator of a tractor-trailer, the space cushion may be reduced on the sides to only inches, yet the successful maintenance of this space may involve the same skill as is required for the passenger car operator but simply at a much higher level.

3. Determination of Amenability to Training of Identified Factors

Once specific behavioral parameters have been identified that differentiate between novice and experienced drivers, the next question is

to what extent these factors are amenable to training. Can the novice driver be trained to use his eyes in a manner more similar to that of the experienced driver? Can the beginning driver learn to shift his attention among several tasks and monitor them successfully? Generally, to what extent can the novice driver be trained to function more like the experienced driver? Each human performance parameter should be investigated individually and possibly in combination with other identified parameters to ascertain the value of training and practice.

This step, like steps 1 and 2, will be time consuming and costly. However, if critical parameters can be shown to be amenable to training, they offer exciting possibilities for driver preparation programs.

4. Development of Training Procedures (Simulators? Games? Interactive Devices?)

To the extent that there is evidence that the skill factors under consideration are amenable to training, then investigation should be made of how the skills might best be modified. It is highly unlikely that all identified skill factors will prove equally amenable to training. For example, desirable eye movement patterns could perhaps be programmed without too much difficulty, but variability in performance may be a more direct consequence of experience per se and hence not render itself to rapid modification. These are issues that must be resolved empirically.

One of the major concerns in any modification or expansion of driver preparation programs is that of cost. However, it may not be necessary for public funding to support all of the training deemed desirable. To the extent that skill factors could be clearly identified, it may be possible to incorporate them into interactive devices that can be developed and manufactured by the private sector. The veritable explosion of computerized games that interact with the player suggest a market for the

imaginative incorporation of identified skill factors into interactive devices and games that can be played in competition with others or can be used alone. Such development and marketing of devices could lead to the acquisition and refinement of skills with minimal investment by government. Furthermore, skill practice under such protected conditions could readily provide the opportunity to observe how alcohol and other drugs affect performance.

5. Compilation of Procedures into Driver Preparation Program

Once methods are developed for training those identified factors shown to be amenable to training, the various methods, including the use of interactive devices and games, should be compiled into a comprehensive driver preparation program. Such a program may coordinate skill training with basic behind-the-wheel training provided by the formal driver education program. Both skill training and behind-the-wheel training may be coordinated into a larger driver education program as described below.

6. Coordination With Televised Material Covering Classroom Portion of Driver Education (May Include Parents)

The skills training and beginning behind-the-wheel training should be coordinated with the information presently covered in the standard 30 hours of classroom instruction. However, it is recommended that the bulk of the information be presented via television. Television presentation will allow for more careful programming and could communicate far more effectively much more information than is presently covered in most driver education classrooms. Textbooks and/or other prepared materials should be used in conjunction with the televised material, and there should be a classroom opportunity for questions, answers, and discussion. Furthermore, students taking the course should be required to take a short quiz each week to insure that they are keeping up with the required assignments.

If driver education instructors met their classes only once a week for questions and quizzes, they would have additional time to devote to the behind-the-wheel instruction. This extra time should be used differentially to enrich the training of students whose need for it is greater.

The use of televised material presented on public television, with each segment repeated several times during the week, would enable viewing by parents and siblings, as well as the students enrolled in the course. To the extent that parents could be exposed to the educational materials, they may better serve as monitors of on-road driving experienced acquired by their youngsters as described below.

7. Parent Involvement Program

The use of parents as monitors of on-road experience is an option in many states in which beginning drivers may obtain a permit before they can pass the on-road test. As described elsewhere (Waller and Reinfurt, 1973; Waller, 1974), the use of parents where available offers the most promising opportunity to increase monitored behind-the-wheel experience at minimal cost to the taxpayer. Parent involvement can be enhanced if the driver preparation program makes clear to the parents the very real limitations of driver education and the importance of continued monitored practed. The driver education instructor could provide the parent with a workbook describing the skills in which the youngster especially needs practice. At the present time too many parents believe that if their son or daughter completes driver education he or she is ready for full fledged driving.

The involvement of parents may have additional spinoff in that parents will have greater opportunity to observe their youngster's performance and assure themselves that the performance is adequate before allowing unmonitored driving to occur. There is the additional possibility that the

exposure of the parent to educational materials may improve the driving practices of the adult population as well as those of the young beginning driver.

Figure 1 summarizes the portion of this model that relates directly to driver education and training.

Potential Coordinated Research Efforts in Driver Licensing

The careful definition of behavior involved in driving and the skills that differentiate between novice and experienced drivers offers unprecedented opportunities for upgrading and enhancing driver licensing programs. The next step is to establish minimal levels of performance on each identified parameter for each type of licensure. Minimum standards must be established for beginning drivers of passenger cars, motorcycles, heavy trucks, and buses, as well as for licensure of special driver groups. Once performance standards have been established, the measuring instruments should be compiled into test batteries and areas of overlap eliminated.

The resulting test batteries would have to be tailored to conform to existing constraints and pilot tested in the field to verify their operational feasibility. Eventually the test batteries should be used in a licensure demonstration project.

8. Determination of Minimum Level of Each Factor Required for Different Driver Groups

Exploration of skill factors involved in driving as described in Step 2 would be based on relatively small numbers of drivers carefully evaluated on a wide range of parameters. Those parameters that appear to differentiate among driver groups would be further investigated on larger population of driver groups, including beginning drivers, operators of heavy truck, motorcycle operators, etc. The purpose here is not to establish that there are differences among groups but rather to establish

standards or norms for each group. Decisions would have to be made as to the levels of performance required for certain subpopulations, such as the medically handicapped, and the types of restrictions that would be appropriate for a given level of performance.

9. Compilation of Scales Into Performance Test Batteries, Elimination of Overlap

Once decisions have been made concerning the minmal levels of performance required for licensure of different driver groups, the measuring instruments will be compiled into a performance test battery. As in the case of driver preparation, factors found to correlate highly with other factors could be eliminated without great sacrifice of validity.

10. Tailoring of Test Battery to Existing Constraints

The test batteries must be useable within existing constraints. They must be such that they can be administered by available personnel with whatever additional training may be feasible. They must require no more sophisticated equipment than can be purchased with available resources and housed in available space. They must also fit within the legal constraints that obtain. Once the test batteries have been modified to fit within existing constraints, they should be field tested on a limited basis to identify any unforeseen problems in their use, and identified problems should be resolved.

11. Use of Test Battery in Licensure Demonstration Project

After resolution of problems identified in the field testing, a large scale demonstration project should be undertaken using the new procedures. This project may include one group administered a traditional test battery, another group administered the neewly developed test battery, and a third group receiving the new test battery plus appropriate remedial training whenever indicated by test performance, using the training procedures

described earlier. For beginning operators of passenger cars the demonstration project could be conducted in conjunction with a parent involvement program allowing for several levels of licensure based on a combination of elapsed time and demonstrated competence (Waller and Reinfurt, 1973; Waller, 1974.)

Potential Coordinated Research Efforts in Highway and Vehicle Design

The careful definition of behaviors involved in driving and the careful description of what the spectrum of drivers can actually do offers an excellent opportunity to evaluate our present highway and vehicle system. The skill factors identified in Steps 1 and 2 should be compared with highway engineering standards and practices and vehicle standards. Discrepancies between the demands of the system and driver capabilities identified in Steps 2 and 8 should be reconciled either through modification of the vehicle or driving environment, retraining of the driver, or, if neither of these is feasible, restriction of certain drivers.

12. Investigation of Possible Role of Factors in Crashes of Different Driver Groups

When the differences among driver groups, e.g., novice, experienced, and older drivers, are identified, it may be worthwhile to examine the crashes experienced by these different groups to ascertain to the extent possible the role of the identified factors in these crashes. Previous studies have analyzed crashes by driver group but not in the manner proposed here. While it has been demonstrated that youong inexperienced drivers use their eyes differently from more experienced drivers, the information has not been applied to specific types of crashes. Nor has there been an analysis of any differences in eye movement patterns between

middle age experienced drivers and elderly drivers, who may be engaging in quite different eye movement behavior for reasons not yet determined.. To what extent existing information on crashes could be used for this purpose is not known, but it is recommended that the entire issue be investigated.

13. Determination of Compatibility of Driver Performance With Highway Engineering Standards and Vehicle Standards

Whether or not it is possible to relate the identified factors to crash experience of different groups, it is still worthwhile to examine the factors and relate them to existing highway engineering standards and practices as well as vehicle standards. Previous in-depth studies of crashes almost invariably took the existing highways and vehicles as givens and focused almost entirely on whether the driver was able to compensate for whatever problems might arise. The information resulting from Steps 2 and 8 should for the first time provide an accurate picture of how drivers actually perform, as opposed to how our current system of traffic law says they should be able to perform. This information should make it possible for the first time to evaluate highway engineering practices and vehicle standards to determine the extent to which they are compatible with what drvers actually can do. This effort cannot be conducted without additional empirical investigation, but such investigation should enable the development of a total driver-vehicle-highway system that optimizes the opportunity for safe performance.

14. Modification of Standards and Practices Where Appropriate

To the extent that incompatibilities are identified between actual driver performance and highway and vehicle engineering practices and standards, investigation should be undertake of the extent to which highway engineering practices and vehicle standards may be modified to enable the spectrum of drivers to perform in a more satisfactory manner.

Investigation should also be made of the feasibility of retraining drivers so they can perform satisfactorily in relation to the existing highway-vehicle system. Decisions would have to be made as to which approach is more promising to achieve compatibility.

15. Imposition of Restrictions on Driver Populations Where Necessary

To the extent that it is not feasible to modify highway engineering practices and vehicle standards to increase their compatibility with existing driving performance, and to the extent that special training procedures cannot modify the driver behavior in question, the information gleaned from the above analysis should be used as an empirical basis for imposing realistic restrictions on certain driver groups. The imposition of restrictions will be based on a clear understanding of the requirements of the tasks and the particular limitations in performance of the driver groups involved.

For the young driver, there is evidence that such restrictions placed on them as a group can reduce motor vehicle injuries and deaths. The imposition of curfews for young drivers appears to reduce their crashes, as do laws increasing the age at which alcohol may be purchased. Such restrictions limit the conditions under which the initial acquisition of driving skill may be acquired and thus serve to protect the young driver during the period when error rates are highest.

Summary and Conclusion

Motor vehicle injuries and deaths constitute a major public health problem, in large part because they strike the young disproportionately. It is well recognized that young beginning drivers have more than their share of motor vehicle crashes and experience much higher death rates. How

much of their problem is attributable to youth and how much to inexperience is not clear, but it is well known that in the acquisition of any complex skill many more errors will be made in the initial stages than in later ones. This basic principle of learning has been acknowledged in skills training in the air force, the space program, industry, and sports, and extensive research has been conducted to analyze carefully the kinds of behaviors involved and how they might be modified. However, no such analysis has ever been conducted for the driving task, where the potential payoff may be greater than in all the other areas combined.

It is proposed that a careful human factors analysis of the driving task be undertaken, based on empirically demonstrated differences among driver groups. While the proposed undertaking would be costly in time and money, it would be far less costly than continuing to spend the enormous sums currently going into what appear to be ineffective programs. Simply to eliminate current programs is no solution, either, since young people <u>are</u> going to learn to drive, and when they do they will make more errors in the early stages than later. The ultimate goal is to enable young people to acquire their initial driving skill under circumstances that are less lethal than what currently obtain. It may be that much of the skill acquisition could occur in practice on interactive devices designed to incorporate behavioral skills identified as important to effective driving. On-road practice could occur under less hazardous conditions through the use of greater parent involvement, limitations on times and places where driving could occur, and levels of licensure based upon demonstrated performance. The education portion of driver preparation could be handled much more effectively and efficiently through the use of well programmed television made available to parents and siblings, as well as students enrolled in the course.

The human factors analysis of the driving task is the foundation for the proposed effort. However, once such a careful empirical analysis is conducted, its value would extend far beyond driver preparation. The information gleaned from such an analysis would enable, for the first time, the development of an intelligent comprehensive drive-vehicle-highway system.

Underlying this proposal is the requirement that there be available support for basic research in this area. This has not been the case in the past. In view of the major health problem posed by traffic crashes, this lack of support for basic research is most puzzling. The constraints placed upon research undertaken in this area contrast markedly with those obtaining for other health problems. For example, cancer research is not funded on the basis of whether it will show a demonstrable reduction in cancer deaths within the next year or two. Research on heart disease does not have to guarantee a signficant reduction in heart attacks over the next five years in order to gain support. In most health related research there is the recognition that some of the most valuable breakthroughs in knowledge arise out of inquiry that would not have been given high priority in terms of immediate payoff. It is interesting to speculate how much progress would have been made in heart and cancer research had investigative efforts been constrained by the types of restrictions that prevail in the area of driver research.

The recognition is long overdue that traffic crashes constitute a major health problem and that certain advances can be made only through long term research. The basic guidelines for such research are well established. What is needed is commitment and support.

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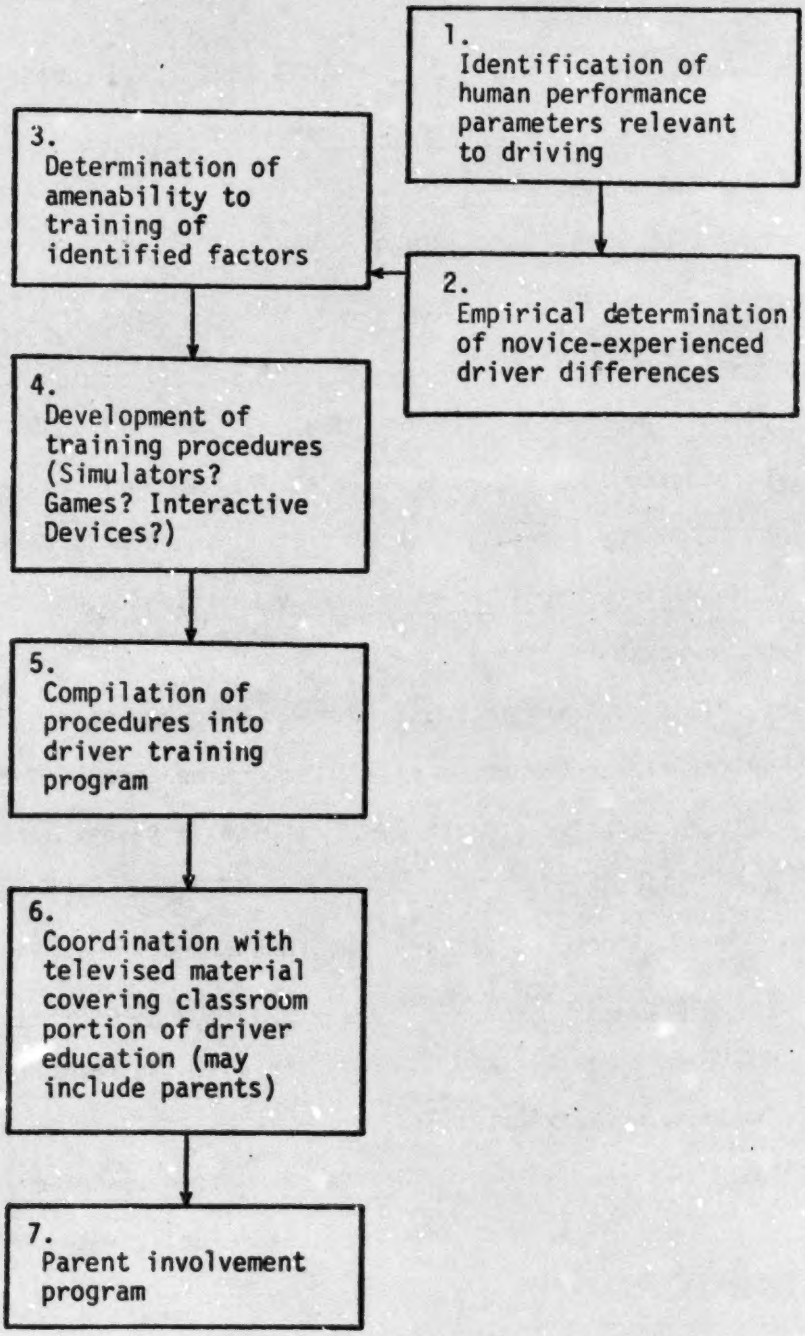
1.
Identification of human performance parameters relevant to driving
2.
Empirical determination of novice-experienced driver differences
3.
Determination of amenability to training of identified factors
4.
Development of training procedures (Simulators? Games? Interactive Devices?)
5.
Compilation of procedures into driver training program
6.
Coordination with televised material covering classroom portion of driver education (may include parents)
7.
Parent involvement program

Figure 1. Proposed Program for Driver Education and Training of Young Drivers.

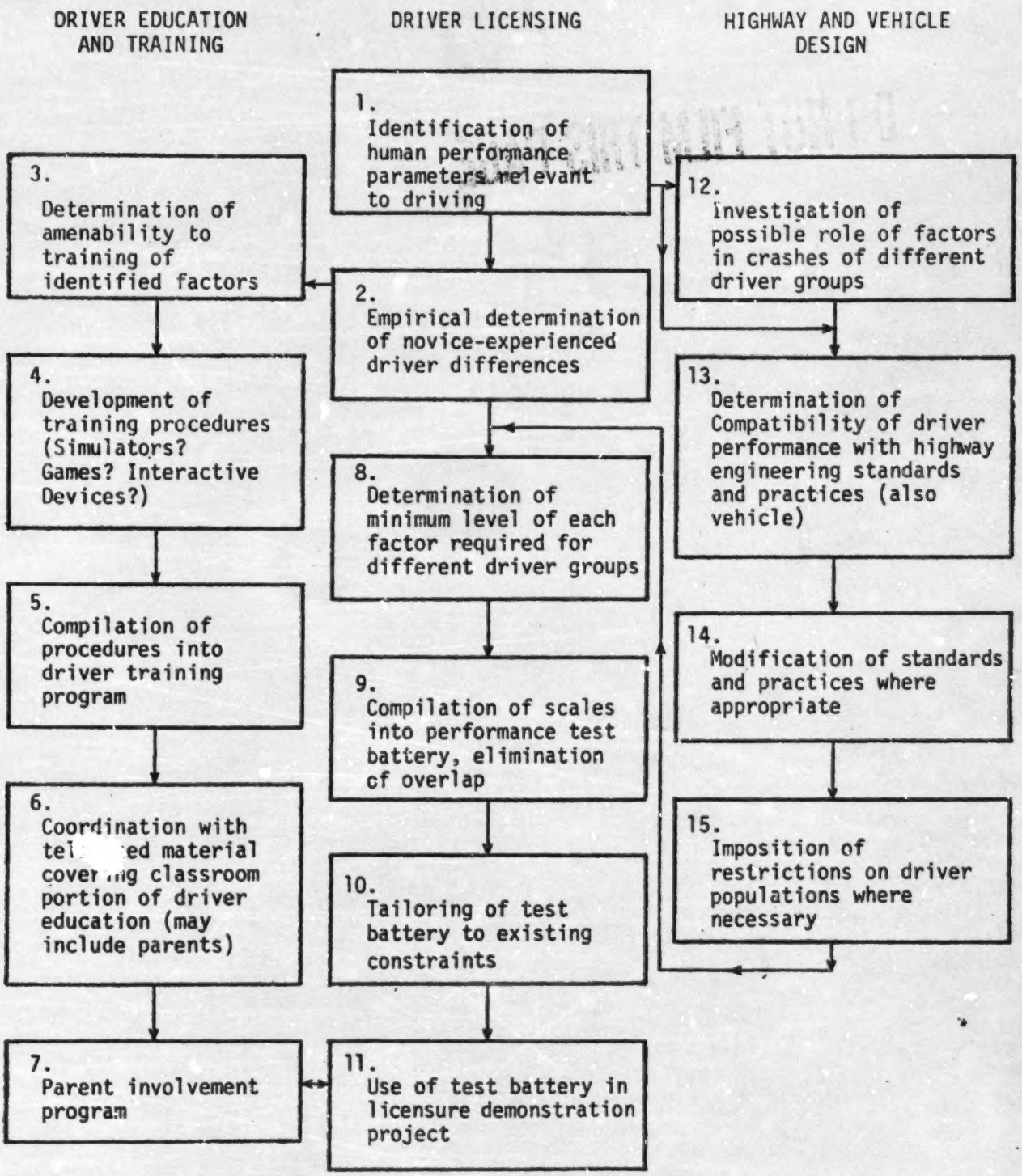
DRIVER EDUCATION AND TRAINING
DRIVER LICENSING
HIGHWAY AND VEHICLE DESIGN
1. Identification of human performance parameters relevant to driving
2. Empirical determination of novice-experienced driver differences
3. Determination of amenability to training of identified factors
4. Development of training procedures (Simulators? Games? Interactive Devices?)
5. Compilation of procedures into driver training program
6. Coordination with tel ed material cover ng classroom portion of driver education (may include parents)
7. Parent involvement program
8. Determination of minimum level of each factor required for different driver groups
9. Compilation of scales into performance test battery, elimination of overlap
10. Tailoring of test battery to existing constraints
11. Use of test battery in licensure demonstration project
12. Investigation of possible role of factors in crashes of different driver groups
13. Determination of Compatibility of driver performance with highway engineering standards and practices (also vehicle)
14. Modification of standards and practices where appropriate
15. Imposition of restrictions on driver populations where necessary

Figure 2. Potential Coordinated Program in Driver Education and Training, Driver Licensing, and Highway and Vehicle Design.